DOCUMENT RESUME

ED 051 287 TM 000 603

AUTHOR	Lord, Frederic M.
TITLE	Tailored Testing, An Application of Stochastic Approximation.
INSTITUTION	Educational Testing Service, Princeton, N.J.
SPONS AGENCY	Office of Naval Research, Washington, D.C. Psychological Sciences Div.
REPORT NO	RM-71-2
PUB DATE	Feb 71
NOTE	32p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	Academic Ability, Computer Programs, Guessing (Tests), *Item Analysis, Mathematical Models, *Mental Tests, Probability Theory, *Psychometrics, Sampling, Scores, Scoring, *Statistical Analysis, Test Construction, *Testing
IDENTIFIERS	Item Difficulty, Stochastic Approximation, *Tailored Testing

ABSTRACT

Some stochastic approximation procedures are considered in relation to the problem of choosing a sequence of test questions to accurately estimate a given examinee's standing on a psychological dimension. Illustrations are given evaluating certain procedures in a specific context. (Author/CK)

ED051287

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

APR 16 1971

RM-71-2

TAILORED TESTING,

AN APPLICATION OF STOCHASTIC APPROXIMATION

Frederic M. Lord

Office of Naval Research Contract N00014-69-C-0017
Project Designation NR 150-303
Frederic M. Lord, Principal Investigator

Educational Testing Service
Princeton, New Jersey

February 1971

Reproduction in whole or in part is permitted for any purpose of the United States Government.

This document has been approved for public release and sale; its distribution is unlimited.

TM 000 603

TAILORED TESTING, AN APPLICATION OF STOCHASTIC APPROXIMATION*

This paper deals with a rather difficult problem in educational (or mental) testing. However, the statistical reader need not be familiar with the basic ideas of classical mental test theory--in particular, the notions of "true score" and "reliability." The inconsequence of the classical theory here is surprising. Perhaps this indicates that the approach to be used is no less fundamental than the classical theory itself.

Consider the educator or psychologist whose purpose is to measure "ability" or achievement (or other trait) for a number of individuals. Let us denote the trait being measured by θ and choose a scale of measurement so that θ varies from $-\infty$ to $+\infty$. For present purposes, θ is not a chance variable; it is simply a parameter describing a person.

The educator has a large bag full of test questions called "items." Let us only consider items that are scored "right" or "wrong." Denote the score on item i by $u_i = 1$ or 0. Think of testing just one person; or if a group is to be tested, consider each person individually. We plan to use the individual's responses to a selected subset of the items in order to estimate his value of θ.

If we are to do this, we need to know something about how his responses depend on his ability, that is, something about the function

---

*This work was supported in part by contract N00014-69-C-0017, project designation NR 150-303, between the Personnel and Training Research Programs Office, Psychological Sciences Division, Office of Naval Research and Educational Testing Service. Reproduction in whole or in part is permitted for any purpose of the United States Government.

$$P_i \equiv P_i(\theta) \equiv \text{Prob}(u_i=1|\theta) \qquad (1)$$

This function is called the trace line or item characteristic function or item characteristic curve [5, chapts. 16-17; 4]. It seems reasonable to assume that the function is continuous and monotonic increasing--the higher the ability level, the more the probability of success.

Typically, the item characteristic function is assumed to be a logistic function, or a cumulative normal distribution function; or possibly one of these functions so modified as to have its lower asymptote greater than 0. Some typical item characteristic curves are shown in Figure 1. The meaning of the descriptive parameters a, b, and c need not concern us at this point.

Although the unmodified curves are cumulative distribution functions, it is usually <u>not</u> helpful to think of them in this way. The item characteristic function is best thought of as the regression of the item score u_i on θ.

It is common to assume that for any set of items the conditional probability of success on all the items when θ is fixed is simply the product of the separate probabilities of success. This assumption is known as the assumption of <u>local independence</u>. It implies that items are uncorrelated when ability is held constant (<u>not</u> that they are uncorrelated in ordinary groups of examinees).

To see the reason for the assumption, let us suppose on the contrary that P_{ij}, the probability of simultaneous success on items i and j,

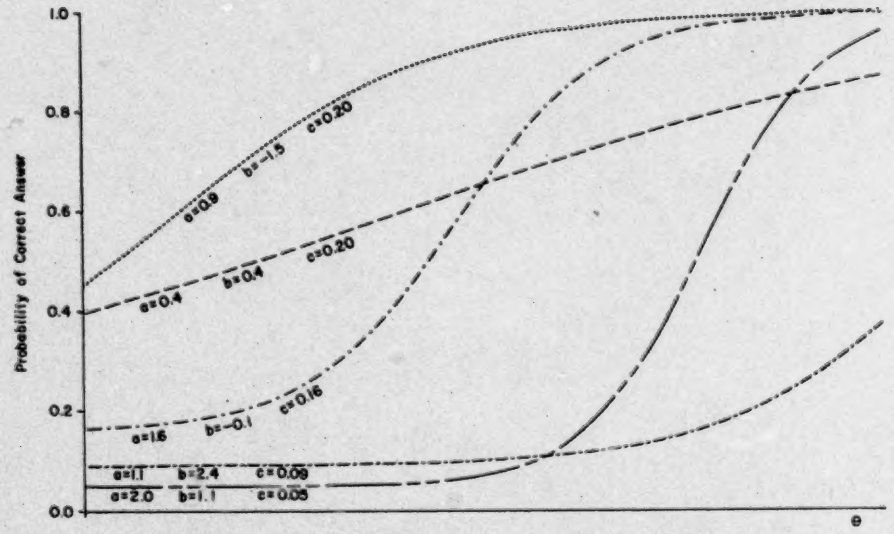

Figure 1. Probability of correct answer as a function of ability, as estimated for five SAT Verbal Items.

is greater than $P_i P_j$. This would mean that even when θ is fixed, there is some psychological dimension that helps to determine whether items i and j are answered correctly. In other words, for fixed θ , items i and j constitute a two-item test measuring some psychological dimension other than θ . This is just the sort of situation that the assumption of local independence is intended to rule out. For simplicity, we wish to consider tests that measure a single psychological dimension rather than tests that measure several at the same time.

Let us suppose that the items in the educator's bag have been extensively pretested, so that the shape of the item characteristic curve for each item is known to a good approximation. Let us select from the bag a large set of items whose characteristic curves differ only by a translation along the θ -axis. Thus, we may describe item i by a parameter b_i , called the <u>difficulty</u> of item i , defined by the equation

$$P_i(b_i) = \alpha \quad ,$$

where α is some constant, possibly 1/2, chosen by the statistician. Since all characteristic curves differ only by a translation, the curve for item i will be written as $P(\theta - b_i)$.

Suppose now that we administer many items to a particular student. By trial and error, we can find approximately the item difficulty level b at which the student has probability of success α . Once we have done this, we can now estimate the student's ability level as approximately $\theta = b$.

As I have outlined it, the problem of estimating θ is a standard problem in stochastic approximation [8]. Specifically, the stochastic approximation problem is to choose a sequence of items--that is, a sequence of b_i --in such a way that we can estimate θ from the resulting sequence of u_i .

The item sequence constitutes a tailored test, so called because the items are chosen specifically in an attempt to measure one particular individual as effectively as possible.

Although tailored testing can be carried out in a paper-and-pencil situation, it is relatively difficult to do so. On the other hand, if a computer is available, as it is in many educational institutions, then a large number of test items can be stored in the computer. Once an effective rule for selecting items is provided, the computer can easily produce a test specially tailored to the ability level of each individual being tested.

According to the Robbins-Monro stochastic approximation procedure, the difficulty of the $(v + 1)$ -st item is to be determined by the rule

$$b_{v+1} = b_v + d_v(u_v - \alpha) \tag{2}$$

where $d_1, d_2, \cdots$ is a suitable decreasing sequence of positive constants chosen in advance by the statistician [8, 7, 3]. Typically,

$$d_v = d_1/v \quad , \tag{3}$$

a harmonic sequence. Each d_v determines a "step size" by which item difficulty is adjusted--upwards if $u_v = 1$, downwards if $u_v = 0$.

This rule for choosing items has the following effect: Each time the student answers an item correctly, the next item administered is chosen to be more difficult. Each time his answer is incorrect, the next item is chosen to be easier. The increment or decrement in item difficulty is large at the start of the testing, when little is known about the student's ability level, and becomes smaller as testing proceeds. All these properties of the rule seem intuitively desirable.

Unfortunately, a strict adherence to this rule would require storing 2^n items in the computer before beginning to test, where n is the total number of items (presumed to be fixed in advance) to be administered to a single examinee. In most tests composed of dichotomously scored items, $n \geq 25$.

In order to avoid preparing and storing 2^n items, a method called the up-and-down method, originally designed for testing explosives, can be used [8]. In this method, the rule for choosing items is the same as under the Robbins-Monro procedure except that d_v in (2) is replaced by some predetermined fixed step size d.

When $\alpha = 0.5$, the up-and-down rule becomes

$$b_{v+1} = \begin{cases} b_v + d & \text{if } u_v = 1, \\ & \text{with probability } P(\theta - b_v), \\ b_v - d & \text{if } u_v = 0, \\ & \text{with probability } Q(\theta - b_v), \end{cases} \tag{4}$$

where $Q = 1 - P$. Figure 2 may be helpful in visualizing the sequence of items administered. It is assumed that the difficulty of the first item

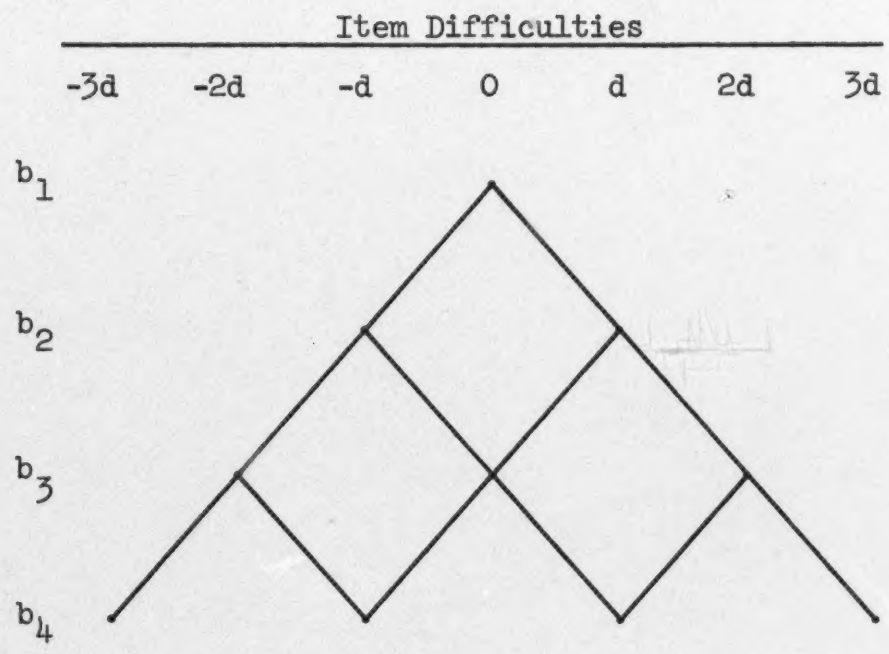

Figure 2. Possible sequences of item difficulties. When the difficulty of the first item is $b_1 = 0$, any path proceeding downwards from the apex represents a possible sequence.

is $b_1 = 0$. Any downward path starting at the apex of the figure represents a possible sequence of item difficulties for a single individual.

In principle, at least, we must store one item in the computer for each intersection shown in Figure 2. Thus if n items are to be administered to the examinee, the total number of items to be prepared and stored before testing should be $n(n + 1)/2$. It is quite practical to carry on computer-based testing with the up-and-down method, especially if a few shortcuts are taken to reduce the total number of items required.

It is clear from Figure 2 that the up-and-down method corresponds to a random walk. The transition probabilities $P(\theta - b_v)$ and $Q(\theta - b_v)$ are stationary. They depend on b_v , but they do not depend on v when b_v is given.

The up-and-down method has been widely recommended and used in bioassay applications. Dixon and Mood [2] obtained a large-sample approximation to the maximum likelihood estimator of θ for the up-and-down method, on the assumption that $P(\theta)$ is a normal ogive. The likelihood function is

$$L(u_1, u_2, \ldots, u_n | \theta; b_1, b_2, \ldots, b_n) = \prod_{v=1}^{n} [P(\theta - b_v)]^{u_v} [Q(\theta - b_v)]^{1-u_v} , \quad (5)$$

where the value of b_v for $v > 1$ depends on the values of u_{v-1} , u_{v-2} ,..., u_1 , as shown by equation (4).

Consider the following three simple methods for scoring the student's responses to the items administered:

1. The "final-difficulty score," b_{n+1}, the difficulty of the $(n+1)$-th item administered, as defined by equation (2). Robbins and Monro showed that for suitable sequences $\{a_v\}$, the score b_v converges in probability to θ as v becomes large.

2. The "number-right score," $\sum_{v=1}^{n} u_v$, or the "proportion-right score," $\frac{1}{n}\sum_{v=1}^{n} u_v$. The former is the score most commonly used in scoring conventional mental tests.

3. The "average-difficulty score," $X = \frac{1}{n}\sum_{v=2}^{n+1} b_v$. This score is simply the average of the difficulty parameters of the items administered to the student, omitting the first (since the first item is the same for all examinees) and including b_{n+1}.

[Before going ahead, the reader may wish to make a guess as to the relative merits of these three scoring methods for the up-and-down (fixed step size) procedure.]

When the step size shrinks appropriately as n increases, as in the Robbins-Monro procedure, b_{n+1} is a good estimator for θ. When the step size is fixed, as in the up-and-down method, b_{n+1} is no longer a consistent estimator for θ, nor does its sampling variance approach zero as n becomes large.

Surprisingly, it turns out that when step size is fixed number-right score is perfectly correlated with b_{n+1}.

Brownlee, Hodges, and Rosenblatt [1] have shown that the average-difficulty score is asymptotically equivalent to the maximum likelihood estimator for θ found by Dixon and Mood. Although no optimum small-sample properties have been proven for the average-difficulty score, it appears to be the score of choice for the up-and-down method at present. (See Wetherill [9] for empirical studies of Robbins-Monro, up-and-down, and other procedures.)

The remaining problem for discussion here is the evaluation of different testing procedures and of the different choices of parameters such as d and α.

It frequently happens that organizations test similar groups of students year after year. In this case, they have available an excellent prior distribution for the parameter θ based on records of past performance. In such situations, the careful design of a tailored testing procedure would certainly be based on a Bayesian approach (see Owen [6]).

The Bayesian approach will not be used here. For one thing, it complicates the mathematics. For present purposes, it seems better to present results in a form that can be used by a variety of different readers having a variety of prior distributions for θ.

Brownlee, Hodges, and Rosenblatt have a recursive method for evaluating $\mathcal{E}(X|\theta)$, the expected score for any given θ; also for evaluating $\sigma^2(X|\theta)$, its conditional variance. For example,

$$\begin{aligned}\mathcal{E}[X_{v+1}-(v+1)\theta \mid \theta;\ b_1=b] = {} & P(\theta-b)\ \mathcal{E}[X_v-v\theta \mid \theta;\ b_1=b+d] \\ & + Q(\theta-b)\ \mathcal{E}[X_v-v\theta \mid \theta;\ b_1=b-d] \\ & + (d-\theta+b)\ P(\theta-b) - (d+\theta-b)\ Q(\theta-b)\ .\end{aligned} \tag{6}$$

It is quite practical, even for sizeable n, to compute recursively on a computer the desired expectations and sample variances, for each of a variety of values of θ.

This brings us to an interesting problem in statistical inference. In bioassay θ is typically the dose of a drug at which $P(\theta) = \alpha$. Usually, any bias in the estimation procedure is a serious problem. In bioassay, it would seem appropriate to use the mean-square error

$$\text{MSE} = \mathcal{E}(X - \theta)^2 \tag{7}$$

$$= \sigma^2(X|\theta) + [\mathcal{E}(X|\theta) - \theta]^2$$

as an appropriate measure of the effectiveness of a particular procedure.

In mental testing, on the other hand, biased estimates of θ are perfectly satisfactory provided the bias is the same for each student tested. The fact is that in most situations the origin and the unit of measurement for measuring ability is arbitrary. Thus the parameter

$$\theta^* = A + B\theta \quad ,$$

where A and B are any constants with $B > 0$, is usually quite as satisfactory as the parameter θ itself. For example, the number-right score $\sum_{v}^{n} u_v$ is just as satisfactory an estimator as the proportion-right score $\frac{1}{n}\sum_{v}^{n} u_v$ although these scores clearly do not estimate the same parameter. Both scores are satisfactory despite the fact that the sampling variance of the first is n^2 times as large as the sampling variance of the second.

If we cannot discriminate among estimation procedures on the basis of bias and sampling variance, how are we to evaluate different estimation procedures with respect to each other? If the purpose of the test is to separate students with higher θ from those with lower θ, it is clear that in some sense we would like

$$\frac{\varepsilon(X|\theta_2) - \varepsilon(X|\theta_1)}{\sigma(X|\theta_1)}$$

to be large, where $\theta_2 = \theta_1 + \Delta_\theta$ and Δ_θ is a small increment in θ, sufficiently small so that $\sigma(X|\theta_2)$ is approximately equal to $\theta(X|\theta_1)$. For present purposes, the effectiveness of a psychological testing procedure will be described by $I_x(\theta)$, a function of θ, where

$$I_x(\theta) = \frac{K[\varepsilon(X|\theta+\Delta_\theta) - \varepsilon(X|\theta)]^2}{\sigma^2(X|\theta)} \quad . \tag{8}$$

The constant of proportionality K and the choice of Δ_θ affect the size of $I_x(\theta)$ but are irrelevant for comparing different testing procedures as long as the same values are used for each procedure.

The sorts of results obtained are illustrated in Figures 3 and 4. The ability level of the examinee is shown along the horizontal axis in each figure. The effectiveness of each test procedure is shown along the vertical axis (although different numerical scales are used in the two figures). Each curve shows the effectiveness of a procedure as a function of ability level.

The curves labeled "standard" are displayed to provide familiar bench marks. Each standard test is a conventional (not a tailored) test, composed

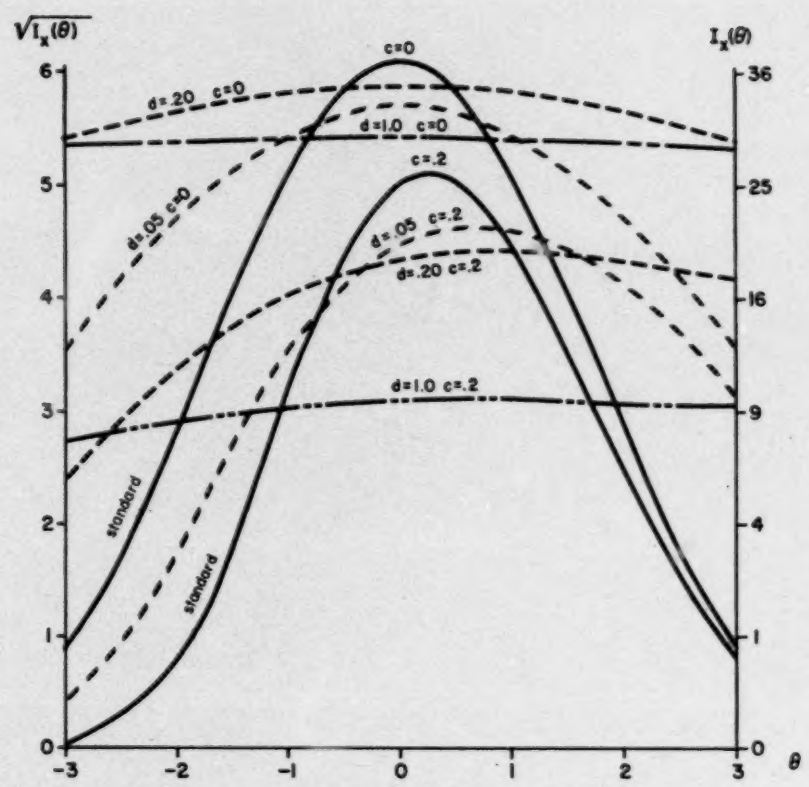

Figure 3. A comparison of measurement efficiency for the up-and-down method when there is chance success (c = .2) and when there is not (c = 0). n = 60 .

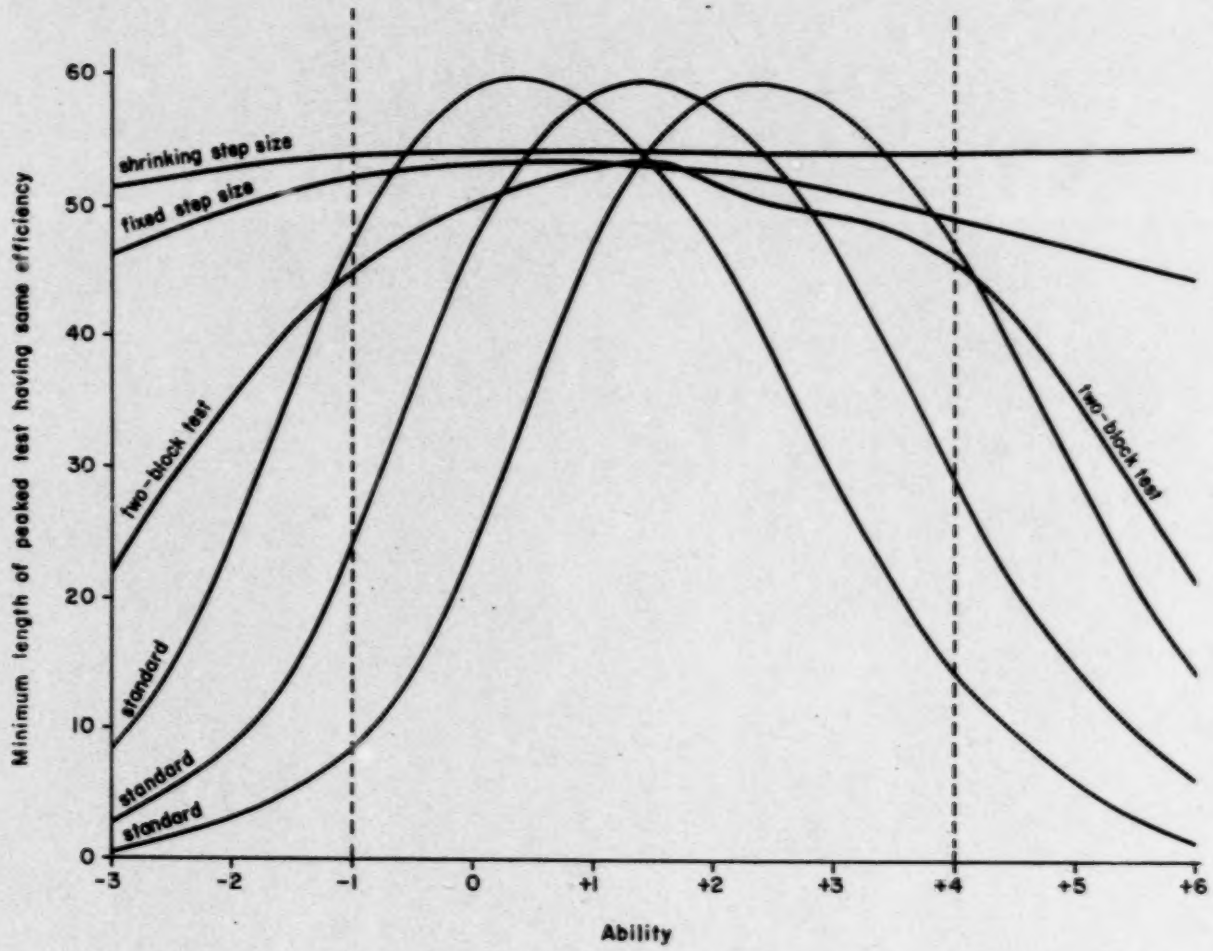

Figure 4. Efficiency of three 60-item tailored testing procedures as compared to that of three conventional 60-item peaked ("standard") tests, as a function of examinee ability.

entirely of items of equal difficulty, the score being the number of right answers. For such a test, the number of right answers is known to be a sufficient statistic for estimating θ. Thus a horizontal line passing through the maximum of a standard curve represents an upper limit to the effectiveness of any test procedure based on dichotomously scored items--an upper limit that ordinarily would be attainable only if the examinee's true value of θ were known in advance of the testing.

The tests shown in Figures 3 and 4 all require administering $n = 60$ items to each student. The three broken curves at the top of Figure 3 display the effectiveness of three tailored tests with fixed step sizes $d = .05$, $.20$, and 1.0. In the situation illustrated, a step size of .05 is seen to be too small. It seems that a step size around $d = .20$ is most effective for the circumstances considered. A step size of 1.0 would be necessary, however, if it were desired to measure accurately at ability levels above $\theta = 4$ or below $\theta = -4$.

The three curves labeled $c = 0$ describe a tailored testing with items that cannot be answered correctly by guessing. The curves labeled $c = .2$ describe tailored tests composed of items that will be answered correctly at least 20 percent of the time, even by examinees at very low ability levels. The figure shows that when low-ability students can sometimes answer items correctly (whether by random or nonrandom guessing), there is a considerable loss of measurement effectiveness. A part of this loss may be recovered by a more suitable choice of the parameter α; however, most of the loss is irretrievable.

Figure 4 is similar to Figure 3. The vertical axis still measures the effectiveness of the procedure, although expressed in different units. All the curves relate to tests composed of items that may be successfully answered by random guessing. The curve labeled "shrinking step size" represents the "best" Robbins-Monro procedure found for a certain purpose after investigating a large number of such procedures. The "fixed step size" curve represents similarly the "best" of a large number of up-and-down procedures. The "two-block test" represents a "best" two-stage procedure. The first stage is the administration of a single conventional test with all items at the same difficulty level. The number-right score on this "routing test" is used to assign the examinee to take a single second-stage test, which again is a conventional test consisting of items all at the same difficulty level.

The results displayed in the figure show, among other things, that the up-and-down procedure with fixed step size is in this case almost as efficient as the Robbins-Monro procedure. (Note that figures are displayed here to illustrate types of conclusions obtainable, not to establish conclusions for themselves.)

References

[1] Brownlee, K. A., Hodges, J. L., Jr., and Rosenblatt, M., "The Up-and-Down Method with Small Samples," Journal of the American Statistical Association, 48 (1953), 262-77.

[2] Dixon, W. J. and Mood, A. M., "A Method for Obtaining and Analyzing Sensitivity Data," Journal of the American Statistical Association, 43 (1943), 109-26.

[3] Hodges, J. L., Jr. and Lehmann, E. L., "Two Approximations to the Robbins-Monro Process," in J. Neyman ed., Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability, Volume 1, Berkeley: University of California Press, 1956.

[4] Lazarsfeld, P. F. and Henry, N. W., Latent Structure Analysis, Boston: Houghton Mifflin, 1968.

[5] Lord, F. M. and Novick, M. R., Statistical Theories of Mental Test Scores, Reading, Mass.: Addison-Wesley, 1968.

[6] Owen, R. J., "Bayesian Sequential Design and Analysis of Dichotomous Experiments with Special Reference to Mental Testing," Ann Arbor, Mich.: Author, 1970.

[7] Robbins, H. and Monro, S., "A Stochastic Approximation Method," The Annals of Mathematical Statistics, 22 (1951), 400-7.

[8] Wasan, M. T., Stochastic Approximation, Cambridge: Cambridge University Press, 1969.

[9] Wetherill, G. B., "Sequential Estimation of Quantal Response Curves," Journal of the Royal Statistical Society, 25 (1963), 1-38.

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Educational Testing Service
Princeton, New Jersey 08540

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
TAILORED TESTING, AN APPLICATION OF STOCHASTIC APPROXIMATION

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Technical Report

5. AUTHOR(S) *(First name, middle initial, last name)*
Frederic M. Lord

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
February 1971	17	9

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
N00014-69-C-0017	RM-71-2
b. PROJECT NO. NR 150-303	
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT
This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Office of Naval Research Navy Department Washington, D. C. 20360

13. ABSTRACT

Some stochastic approximation procedures are considered in connection with the following problem. How shall we choose a sequence of test questions in order to estimate as accurately as possible a given examinee's standing on some psychological dimension? Illustrations are given evaluating certain procedures in a specific context.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

Security Classification

JND PPSO 13152

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Mental Test Theory						
Educational Testing						
Stochastic Approximation						

NR 150-303, N-00014-69-C-0017

ONR Distribution List

4 Chief of Naval Research
Code 458
Department of the Navy
Arlington, Virginia 22217

1 Director
ONR Branch Office
495 Summer Street
Boston, Massachusetts 02210

1 Office of Naval Research
Branch Office Chicago
536 South Clark Street
Chicago, Illinois 60605

1 Director
ONR Branch Office
1030 East Green Street
Pasadena, California 91101

6 Director, Naval Research Laboratory
Washington, D. C. 20390
ATTN: Library, Code 2029 (ONRL)

1 Office of Naval Research
Area Office
207 West 24th Street
New York, New York 10011

1 Office of Naval Research
Area Office
1076 Mission Street
San Francisco, California 94103

6 Director
Naval Research Laboratory
Washington, D. C. 20390
ATTN: Technical Information Division

12 Defense Documentation Center
Cameron Station, Building 5
5010 Duke Street
Alexandria, Virginia 22314

1 Commanding Officer
Service School Command
U. S. Naval Training Center
San Diego, California 92133

3 Commanding Officer
Naval Personnel and Training
Research Laboratory
San Diego, California 92152

1 Commanding Officer
Naval Medical Neuropsychiatric
Research Unit
San Diego, California 92152

1 Commanding Officer
Naval Air Technical Training Center
Jacksonville, Florida 32213

1 Dr. James J. Regan, Code 55
Naval Training Device Center
Orlando, Florida 32813

1 Dr. Morton A. Bertin
Office of Naval Research
219 South Dearborn Street
Chicago, Illinois 60604

1 Technical Library
U. S. Naval Weapons Laboratory
Dahlgren, Virginia 22448

1 Research Director, Code 06
Research and Evaluation Department
U. S. Naval Examining Center
Building 2711 - Green Bay Area
Great Lakes, Illinois 60088
ATTN: C. S. Winiewicz

1 Chairman
Behavioral Science Department
Naval Command and Management Division
U. S. Naval Academy
Luce Hall
Annapolis, Maryland 21402

1 Dr. A. L. Slafkosky
Scientific Advisor (Code AX)
Commandant of the Marine Corps
Washington, D. C. 20380

1 Behavioral Sciences Department
Naval Medical Research Institute
National Naval Medical Center
Bethesda, Maryland 20014

1 Commanding Officer
Naval Medical Field Research Laboratory
Camp Lejeune, North Carolina 28542

1 Deputy Director
Office of Civilian Manpower Management
Department of the Navy
Washington, D. C. 20390

1 Director
Aerospace Crew Equipment Department
Naval Air Development Center
Johnsville
Warminster, Pennsylvania 18974

1 Chief
Naval Air Technical Training
Naval Air Station
Memphis, Tennessee 38115

1 Director
Education and Training Sciences Dept.
Naval Medical Research Institute
National Naval Medical Center
Building 142
Bethesda, Maryland 20014

1 Commander
Submarine Development Group TWO
Fleet Post Office
New York, New York 09501

1 Commander
Operational Test & Evaluation Force
U. S. Naval Base
Norfolk, Virginia 23511

1 Mr. S. Friedman
Special Assistant for Research & Studies
OASN (M&RA)
The Pentagon, Room 4E794
Washington, D. C. 20350

1 Chief of Naval Operations, (Op-07TL)
Department of the Navy
Washington, D. C. 20350

1 Chief of Naval Material (MAT 031M)
Room 1323, Main Navy Building
Washington, D. C. 20360

1 Mr. George N. Graine
Naval Ship Systems Command (SHIP 03H)
Department of the Navy
Washington, D. C. 20360

1 Chief
Bureau of Medicine and Surgery
Code 513
Washington, D. C. 20390

1 Chief
Bureau of Medicine and Surgery
Research Division (Code 713)
Department of the Navy
Washington, D. C. 20390

6 Technical Library (Pers-11b)
Bureau of Naval Personnel
Department of the Navy
Washington, D. C. 20370

3 Personnel Research and Development Laboratory
Washington Navy Yard, Building 200
Washington, D. C. 20390
ATTN: Library, Room 3307

1 Commander, Naval Air Systems Command
Navy Department, AIR-4132
Washington, D. C. 20360

1 Commandant of the Marine Corps
Headquarters, U. S. Marine Corps
Code AO1B
Washington, D. C. 20380

1 Technical Library
Naval Ship Systems Command
Main Navy Building, Room 1532
Washington, D. C. 20360

1 Technical Library Branch
Naval Ordnance Station
Indian Head, Maryland 93940

1 Library, Code 0212
Naval Postgraduate School
Monterey, California 93940

1 Technical Reference Library
Naval Medical Research Institute
National Naval Medical Center
Bethesda, Maryland 20014

1 Scientific Advisory Team (Code 71)
Staff, COMASWFORLANT
Norfolk, Virginia 23511

3 Technical Director
Personnel Research Division
Bureau of Naval Personnel
Washington, D. C. 20370

1 Technical Library
Naval Training Device Center
Orlando, Florida 32813

1 Chief, Naval Air Reserve Training
Naval Air Station
Box 1
Glenview, Illinois 60026

1 Dr. Earl I. Jones
Director
Naval Training Research Institute
Naval Personnel & Training Research Laboratory
San Diego, California

1 Head, Personnel Measurement Staff
Capital Area Personnel Service Office-Navy
Ballston Tower #2, Room 1204
801 N. Randolph Street
Arlington, Virginia 22203

1 Director of Research
U. S. Army Armor Human Research Unit
Fort Knox, Kentucky 40121
ATTN: ATSAG-EA

1 Armed Forces Staff College
Norfolk, Virginia 23511
ATTN: Library

1 Director
Behavioral Sciences Laboratory
U. S. Army Research Institute of Environmental Medicine
Natick, Massachusetts 01760

1 U. S. Army Behavior and Systems Research Laboratory
Commonwealth Building, Room 239
1320 Wilson Boulevard
Arlington, Virginia 22209

1 Division of Neuropsychiatry
Walter Reed Army Institute of Research
Walter Reed Army Medical Center
Washington, D. C. 20012

1 Behavioral Sciences Division
Office of Chief of Research and Development
Department of the Army
Washington, D. C. 20310

1 Commandant
U. S. Army Adjutant General School
Fort Benjamin Harrison, Indiana 46216
ATTN: ATSAG-EA

1 Dr. George S. Harker, Director
Experimental Psychology Division
U. S. Army Medical Research Laboratory
Fort Knox, Kentucky 40121

1 LTC William C. Cosgrove
USA CDC Personnel & Administrative Services Agency
Ft. Benjamin Harrison, Indiana 46216

1 Director
Air University Library
Maxwell Air Force Base, Alabama 36112
ATTN: AUL-8110

1 Headquarters, Electronic Systems Division
ATTN: Dr. Sylvia Mayer/ESMDA
L. G. Hanscom Field
Bedford, Massachusetts 01730

1 Commandant
U. S. Air Force School of Aerospace Medicine
ATTN: Aeromedical Library (SMSL-4)
Brooks Air Force Base, Texas 78235

1 AFHRL (TR/Dr. G. A. Eckstrand)
Wright-Patterson Air Force Base
Ohio 45433

1 Personnel Research Division (AFHRL)
Lackland Air Force Base
San Antonio, Texas 78236

1 AFOSR (SRLB)
1400 Wilson Boulevard
Arlington, Virginia 22209

1 Headquarters, U. S. Air Force
Chief, Personnel Research and Analysis Division (AFPDPL)
Washington, D. C. 20330

1 Headquarters, U. S. Air Force
AFPTRBD
Programs Resources and Technology Div.
Washington, D. C. 20330

1 AFHRL (HRTT/Dr. Ross L. Morgan)
Wright-Patterson Air Force Base
Ohio 45433

1 Lt. Col. John E. Dulfer
HQ, AFSC (SDEC)
Andrews Air Force Base
Washington, D. C. 20330

1 LTCOL F. R. Ratliff
Office of the Assistant Secretary of Defense (M&RU)
The Pentagon, Room 3D960
Washington, D. C. 20301

1 Dr. Ralph R. Canter
Military Manpower Research Coordinator
OASD (M&RA) MR&U
The Pentagon, Room 3D960
Washington, D. C. 20301

1 Dr. Andrew R. Molnar
Computer Innovation in Education Section
Office of Computing Activities
National Science Foundation
Washington, D. C. 20550

1 Dr. Alvin E. Goins, Executive Secretary
Personality and Cognition Research Review Committee
Behavioral Sciences Research Branch
National Institute of Mental Health
5454 Wisconsin Avenue, Room 10A02
Chevy Chase, Maryland 20015

1 Office of Computer Information
Center for Computer Sciences and Technology
National Bureau of Standards
Washington, D. C. 20234

2 Executive Secretariat
Interagency Committee on Manpower Research
1111 Twentieth Street, N.W., Room 251-A
Washington, D. C. 20036

1 Director, National Center for Educational Research & Development
U. S. Office of Education
Dept. of Health, Education & Welfare
Washington, D. C. 20202

1 Mr. Joseph J. Cowan, Chief
Psychological Research Branch (P-1)
U. S. Coast Guard Headquarters
400 Seventh Street, S.W.
Washington, D. C. 20226

1 ERIC Clearinghouse on Vocational and Technical Education
The Ohio State University
1900 Kenny Road
Columbus, Ohio 43210
ATTN: Acquisition Specialist

1 ERIC Clearinghouse on Educational Media and Technology
Stanford University
Stanford, California 94305

1 Dr. Don H. Coombs, Co-Director
ERIC Clearinghouse
Stanford University
Palo Alto, California 94305

1 Dr. Richard C. Atkinson
Department of Psychology
Stanford University
Stanford, California 94305

1 Dr. Richard S. Hatch
Decision Systems Associates, Inc.
11428 Rockville Pike
Rockville, Maryland 20852

1 Director
Human Resources Research Organization
300 North Washington Street
Alexandria, Virginia 22314

1 Human Resources Research Organization
Division #1, Systems Operations
300 North Washington Street
Alexandria, Virginia 22314

1 Human Resources Research Organization
Division #3, Recruit Training
Post Office Box 5787
Presidio of Monterey, California 93940

1 Human Resources Research Organization
Division #5, Air Defense
Post Office Box 6021
Fort Bliss, Texas 79916

1 Human Resources Research Organization
Division #4, Infantry
Post Office Box 2086
Fort Benning, Georgia 31905

1 Human Resources Research Organization
Division #6, Aviation
Post Office Box 428
Fort Rucker, Alabama 36360

1 Dr. Edward R. F. W. Crossman
Department of Industrial Engineering
University of California
Berkeley, California 94720

1 Dr. Robert Dubin
Graduate School of Administration
University of California
Irvine, California 02650

1 Dr. Robert J. Seidel
Human Resources Research Organization
300 N. Washington Street
Alexandria, Virginia 22314

1 Dr. Marvin D. Dunnette
University of Minnesota
Department of Psychology
Elliot Hall
Minneapolis, Minnesota 55455

1 S. Fisher, Research Associate
Computer Facility
Graduate Center
City University of New York
33 West 42nd Street
New York, New York 10036

1 Dr. John C. Flanagan
American Institutes for Research
Post Office Box 1113
Palo Alto, California 94302

1 Dr. Robert Glaser
Learning Research and Development
Center
University of Pittsburgh
Pittsburgh, Pennsylvania 15213

1 Dr. Albert S. Glickman
American Institutes for Research
8555 Sixteenth Street
Silver Spring, Maryland 20910

1 Dr. Bert Green
Department of Psychology
Johns Hopkins University
Baltimore, Maryland 21218

1 Dr. Duncan N. Hansen
Center for Computer Assisted Instruction
Florida State University
Tallahassee, Florida 32306

1 Dr. M. D. Havron
Human Sciences Research, Inc.
Westgate Industrial Park
7710 Old Springhouse Road
McLean, Virginia 22101

1 Dr. Carl E. Helm
Department of Educational Psychology
Graduate Center
City University of New York
33 West 42nd Street
New York, New York 10036

1 Mr. Harry H. Harman
Division of Analytical Studies and
Services
Educational Testing Service
Princeton, New Jersey 08540

1 Dr. Lee J. Cronbach
School of Education
Stanford University
Stanford, California 94305

1 Psychological Abstracts
American Psychological Association
1200 Seventeenth Street, N.W.
Washington, D. C. 20036

1 Dr. Bernard M. Bass
University of Rochester
Management Research Center
Rochester, New York 14627

1 Dr. Lee R. Beach
Department of Psychology
University of Washington
Seattle, Washington 98105

1 Dr. Roger A. Kaufman
Graduate School of Leadership
and Human Behavior
U. S. International University
8655 E. Pomerada Road
San Diego, California 92124

1 Dr. George E. Rowland
Rowland and Company, Inc.
Post Office Box 61
Haddonfield, New Jersey 08033

1 Dr. Mats Bjorkman
University of Umea
Department of Psychology
Umea 6, SWEDEN

1 Mr. Roy Ference
Room 2311
U. S. Civil Service Commission
Washington, D. C. 20415

1 Dr. Frederic M. Lord
Division of Psychological Studies
Educational Testing Service
Princeton, New Jersey 08540

1 Dr. Robert R. Mackie
Human Factors Research, Inc.
Santa Barbara Research Park
6780 Cortona Drive
Goleta, California 93017

1 Dr. Stanley M. Nealey
Department of Psychology
Colorado State University
Fort Collins, Colorado 80521

1 Dr. Gabriel D. Ofiesh
Center for Educational Technology
Catholic University
4001 Harewood Road, N.E.
Washington, D. C. 20017

1 Mr. Luigi Petrullo
2431 North Edgewood Street
Arlington, Virginia 22207

1 Dr. Len Rosenbaum
Psychology Department
Montgomery College
Rockville, Maryland 20852

1 Dr. Arthur I. Siegel
Applied Psychological Services
Science Center
404 East Lancaster Avenue
Wayne, Pennsylvania 19087

1 Dr. Paul Slovic
Oregon Research Institute
Post Office Box 3196
Eugene, Oregon 97403

1 Dr. Diane M. Ramsey-Klee
R-K Research & System Design
3947 Ridgemont Drive
Malibu, California 90265

1 Dr. Ledyard R Tucker
Psychology Building
University of Illinois
Urbana, Illinois 61820

1 Dr. John Annett
Department of Psychology
Hull University
Hull
Yorkshire, ENGLAND

1 Dr. Lloyd G. Humphreys
Assistant Director for Education
National Science Foundation
Washington, D. C. 20550

1 Dr. Joseph W. Rigney
Behavioral Technology Laboratories
University of Southern California
University Park
Los Angeles, California 90007

1 Educational Testing Service
Division of Psychological Studies
Rosedale Road
Princeton, New Jersey 08540

RESEARCH REPORT DISTRIBUTION LIST
Educational Testing Service
Princeton, New Jersey

Mr. Alexander Adler
Chief, Scientific & Technical
Communications Section
Manpower Resources Program
Division of Community Health Services
Public Health Service
800 North Quincy Street
Arlington, Virginia 22203

Professor Yrjö Ahmavaara
Tunnelitie 10 A 20
Helsinki 32, FINLAND

Library
American Institutes for Research
P. O. Box 1113
Palo Alto, California 94302

Professor Leonardo Ancona
Institute of Psychology
Universita Cattolica
largo Gemelli
1 - Milano, ITALY

Library
Australian Council for Educational Research
9 Frederick Street
Hawthorn
Victoria 3122, AUSTRALIA

Serials Librarian
Institute of Advanced Studies
Australian National University
Box 4, P. O.
Canberra A. C. T., AUSTRALIA

Mr. Ennio U. Belen-Trujillo
Educational Testing Service
GPO 1271
San Juan, Puerto Rico 00936

Dr. Bruce Bloxom
Department of Psychology
Vanderbilt University
Nashville, Tennessee 37202

Dr. Gunnar Borg
Head, Department of Clinical Psychology
Umeå University
Umeå 2, SWEDEN

Dr. J. C. Brengelmann, Head
Department of Psychology
Max-Planck Institut
Kraepelinstrasse 2
8000 Munich 23, WEST GERMANY

Dr. Hubert E. Brogden
Department of Psychology
Purdue University
Lafayette, Indiana 47907

Mr. Harrison Bryan, Librarian
The University of Sydney
Sydney, New South Wales
AUSTRALIA

Professor R. Buyse
rue St. Georges 1 bis
Tournai, BELGIUM

California Test Bureau Library
Del Monte Research Park
Monterey, California 93940

Dr. Launor F. Carter
Senior Vice President
System Development Corporation
2500 Colorado Avenue
Santa Monica, California 90406

Dr. Raymond Cattell
Department of Psychology
The University of Illinois
Urbana, Illinois 61803

Center for Advanced Study in the
Behavioral Sciences
202 Junipero Serra Boulevard
Stanford, California 94305

Center for Cognitive Studies
William James Hall
33 Kirkland Street
Cambridge, Massachusetts 02138

Library
Center for the Study of Evaluation
Graduate School of Education
145 Moore Hall
University of California
Los Angeles, California 90024

Education Library
The University of Chicago Library
Chicago, Illinois 60637

Dr. Mieczyslaw Choynowski
Polish Academy of Sciences
Institute of Philosophy and Sociology
Room 1334
Warsaw, POLAND

Department of Psychology
Ciencias E Letras de Ribeirao Preto
Caixa Postal, 759
Ribeirao Preto (S.P.), BRASIL

Laboratory of Educational Research
University of Colorado
Boulder, Colorado 80302

Dr. John T. Cowles
Department of Psychology
University of Pittsburgh
Pittsburgh, Pennsylvania 15213

Dr. Lee J. Cronbach
School of Education
Stanford University (P. O. Box 4323)
Stanford, California 94305

Dr. Richard S. Crutchfield
Department of Psychology
University of California
Berkeley, California 94720

The Librarian
Regional Center
P. O. Box 5244
Beirut, LEBANON

Librarian
Department of Labour and Industry
G. P. O., Box 21
Sydney, N. S. W. 2001
AUSTRALIA

Dr. A. Dirkzwager
Department of Psychology
Protestant University Amsterdam
De Boelelaan 1087a
Amsterdam, THE NETHERLANDS

Dr. Edmund E. Dudek, Technical Director
U. S. Naval Personnel Research Activity
San Diego, California 92152

Mr. Jerry W. Dye, Librarian
Nevada Southern University Library
Las Vegas, Nevada 89109

Dr. Ruth E. Eckert
Professor of Higher Education
University of Minnesota
Minneapolis, Minnesota 55455

Staff Librarian
Education Department Buildings
31 Flinders Street
Adelaide, South Australia 5000
AUSTRALIA

Dr. H. J. Eysenck
Director of Psychology Department
The Institute of Psychiatry
University of London
Maudsley Hospital
Denmark Hill
London, S. E. 5, ENGLAND

Mr. Marshall J. Farr
Assistant Head
Engineering Psychology (Code 455)
Psychological Sciences Division
U. S. Office of Naval Research
Washington, D. C. 20390

Mr. Allen H. Fast
Test Development Unit 2-A
U. S. Army Enlisted Evaluation Center
Fort Benjamin Harrison
Indianapolis, Indiana 46249

Dr. Nicholas A. Fattu
Institute of Educational Research
School of Education
Indiana University
Bloomington, Indiana 47405

Dr. Gerhard Fischer
Psychologisches Institut
der Universität
Wien 1, Liebiggasse 5
Vienna, AUSTRIA

Mr. Hans-Georg Frenz
Projekt Schullaufbahnberatung
Hohenzollernstr. 81/III
8 Munchen 13, Germany

Dr. Leonard V. Gordon
School of Education
State University of New York
at Albany
Albany, New York 12203

Dr. Dorothy Green
Room 3G25
U. S. Civil Service Commission
Washington, D. C. 20415

Gruppe Mathematische Psychologie
Neckarstrasse 3
61 Darmstadt, GERMANY

Mr. Gerald Halpern
Collegiate Institute Board
662 Lyon Street
Ottawa 1, Ontario
CANADA

Harvard College Library
Gift and Exchange Division
Cambridge, Massachusetts 02138

Dr. Caryl P. Haskins, President
Carnegie Institution of Washington
1530 P Street, N. W.
Washington, D. C. 20005

Psi Chi Reading Room
College of Arts and Sciences
University of Hawaii
Honolulu, Hawaii 96822

Dr. John K. Hemphill, Director
Far West Laboratory for Education
and Development
Claremont Hotel
1 Garden Circle
Berkeley, California 94705

Dr. S. E. Henricson
Royal Board of Education
Hantverkargt. 29
Stockholm, SWEDEN

Mr. Roger W. Heyns, Chancellor
University of California at Berkeley
Berkeley, California 94720

Dr. John R. Hills, Director
Office of Evaluation Services
Kellum Basement
Florida State University
Tallahassee, Florida 32306

Mr. Fred J. Hitti
32 Winton Road South
Rochester, New York 14623

Dr. Nicholas Hobbs, Head
Division of Psychology and Human Development
George Peabody College for Teachers
Nashville, Tennessee 37203

Mr. Fred W. Hoffman, Director
Pinellas County Board of Public Instruction
Educational Services Division
1895 Gulf-to-Bay Boulevard
Clearwater, Florida 33515

Dr. John L. Holland
7013 Copeleigh Road
Baltimore, Maryland 21212

Dr. Wayne H. Holtzman
Associate Director
Hogg Foundation
University of Texas
Austin, Texas 78712

Dr. Paul Horst
Department of Psychology
University of Washington
Seattle, Washington 98105

Mrs. Dorothy C. Herbert, Librarian
HumRRO Division No. 2 (Armor)
Fort Knox, Kentucky 40121

Dr. Howard H. McFann
Director of Research
HumRRO Division No. 3 (Recruit Training)
P. O. Box 5787
Presidio of Monterey, California 93940

Librarian
HumRRO Division No. 4 (Infantry)
P. O. Box 2086
Fort Benning, Georgia 31905

Director of Research
Attention: Library
HumRRO Division No. 5 (Air Defense)
P. O. Box 6021
Fort Bliss, Texas 79916

Director of Research
Attention: Library
HumRRO Division No. 6 (Aviation)
P. O. Box 428
Fort Rucker, Alabama 36362

HumRRO
The George Washington University
311 North Washington Street
Alexandria, Virginia 22312

Dr. Torsten Husén
Lärarhögskolan
Institute for Educational Research
24, Rålambsvägen
Stockholm 34, SWEDEN

Serials Department
University of Illinois Library
Urbana, Illinois 61803

Indian Statistical Institute Library
203 Barrackpore Trunk Road
Calcutta 35, INDIA

Institute of Industrial Psychology
and Personnel Relations
Helleveien 30
Bergen, NORWAY

Education-Psychology Library
Serials Department
The University of Iowa
Iowa City, Iowa 52240

Professor M. A. Jeeves
Department of Psychology
University of Adelaide
Adelaide, South Australia
AUSTRALIA

Dr. Lyle Jones
Psychometric Laboratory
University of North Carolina
Chapel Hill, North Carolina 27514

Professor E. Lowell Kelly
Department of Psychology
University of Michigan
Ann Arbor, Michigan 48104

Dr. Lorne Kendall, Chairman
Department of Psychology
Simon Fraser University
Burnaby 2, British Columbia
CANADA

Dr. S. A. Kendrick
College Entrance Examination Board
475 Riverside Drive
New York, New York 10027

Dr. Leopold Knops
Psychologisch Instituut
Universiteit te Leuven
Tiense straat 104
Leuven, BELGIUM

Korean Institute for Research in the
Behavioral Sciences
#190, 5-ka
Samsun-dong, Sungpuk-ku
Seoul, KOREA

Library
6570th Pers Research Lab (AMD)
Box 1557
Lackland Air Force Base, Texas 78236

Professor Dr. M. J. Langeveld
Paedagogisch Instituut
Trans 14
Utrecht, HOLLAND

Dr. Paul Lazarsfeld
Fayerweather Hall
Columbia University
New York, New York 10027

Mr. H. M. Ledig
Pädagogische Hochschule Berlin
Marienfelder Str. 74-100
1 Berlin 46, GERMANY

The Librarian
Macquarie University
North Ryde
Sydney, N. S. W. 2113
AUSTRALIA

Professor T. R. McConnell
Center for the Study of Higher Education
4606 Tolman Hall
University of California
Berkeley, California 94720

Measurement and Research Section
Education Library
University of Massachusetts
Amherst, Massachusetts 01003

Professor R. Meili
Psychology Institute
University of Bern
Bern, SWITZERLAND

Dr. Peter F. Merenda
Laboratorio di Psicologia Applicata
Universita di Palermo
Viale delle Scienze
Parco D'Orleans
Palermo, SICILY 90100

Professor Dr. Fabio Metelli
Institute of Experimental Psychology
University of Padua
Piazza Capitaniato
Padua, ITALY

Serials Records
University of Minnesota Libraries
Minneapolis, Minnesota 55455

Dr. Shib K. Mitra
Department of Psychological Foundations
National Council of Educational
Research and Training
H 2/3 Model Town
Delhi 9, INDIA

Dr. W. G. Mollenkopf
231 Hillcrest Drive
Wyoming, Ohio 45215

Dr. G. A. V. Morgan
54 Hawthorne Avenue
Uplands
Swansea, WALES

Professor Ben S. Morris
Director, Institute of Education
University of Bristol
19, Berkeley Square
Bristol 8, ENGLAND

Professor David Mostofsky
Department of Psychology
Boston University
700 Commonwealth Avenue
Boston, Massachusetts 02215

Dr. Paul Naitoh
Supervisory Research Psychologist
U. S. Navy NP Research Unit (Code 8000)
San Diego, California 92152

National Council of Educational
Research and Training
Psychometric Unit
33, Chhatra Marg
Delhi 6, INDIA

The Director
National Institute of Industrial Psychology
14 Welbeck Street
London, W. 1., ENGLAND

Exchange Section
National Lending for Science and Technology
Boston Spa, Yorkshire
GREAT BRITAIN LS 23 7BQ

Head
NAV AV MED CENT
Pensacola, Florida 33516

Department of Psychology
The University of Newcastle
Newcastle, New South Wales
AUSTRALIA

Noryoku-Kaihatsu Kenkyujo
(Educational Test Research Institute)
Toyo-Toki Bldg. 1, Toranomon
Minato-ku, Tokyo
JAPAN

Serials Section
University of North Carolina Library
Chapel Hill, North Carolina 27514

Dr. Melvin Novick
American College Testing Program
P. O. Box 168
Iowa City, Iowa 52240

Professor Joseph Nuttin
University of Louvain
104 Tiense Straat
Louvain, BELGIUM

Mr. N. R. Olu Oshin, Librarian
The West African Examinations Council
Test Development and Research Office
Private Mail Bag 1022
Yaba, Lagos, NIGERIA

Professor A. Ombredane
Laboratoire de Psychologie
115 Avenue, Adolphe Buyl
Bruxelles, BELGIQUE

Dr. Chawal Paeratkul
Educational and Psychological Test Bureau
College of Education, Prasarnmitr.
Bangkok, THAILAND

Professor E. A. Peel
Department of Education
The University
Birmingham 15, ENGLAND

Dr. A. E. G. Pilliner
The University of Edinburgh
The Godfrey Thomsen Unit for
Educational Research
14 George Square
Edinburgh 8, SCOTLAND EH8 9JZ

Department of Experimental Psychology
University of Poona
Poona-7, India

Mr. Sawat Pratoomraj
Department of Educational Research
College of Education, Prasarnmitr
Bangkok, THAILAND

Dr. James Prescott
NICHHD
Department of Health, Education,
and Welfare
Bethesda, Maryland 20014

Psychologisch Instituut "Heymans"
O. Boteringestraat 34
Groningen, THE NETHERLANDS

The Librarian, Serials Section
Main Library, University of Queensland
St. Lucia, Brisbane 4067
AUSTRALIA

The Registrar
Examination Syndicate
Jalan Suleiman
Kuala Lumpur, MALAYSIA

Miss Minette Reid
Test Library
M&E Department
Ontario Institute for Studies in Education
102 Bloor Street West
Toronto 5, Ontario, CANADA

Dr. Alec Rodger
Birbeck College
Malet Street
London, W. C. 1, ENGLAND

Dr. David L. Rosenhan
Department of Psychology
Stanford University
Stanford, California 94305

Mr. G. Dwight Rowe
Coordinator of Educational Research
Milwaukee Public Schools
Administration Building
5225 West Vliet Street
Milwaukee, Wisconsin 53208

Dr. David G. Ryans, Director
Education Research and
Development Center
University of Hawaii
Honolulu, Hawaii 96822

Dr. Johs. Sandven
Educational Research Institute
Wergelandsveien 15
Oslo 1, NORWAY

Mr. A. Schurek, Head
Documentation and Information Service
UNESCO Institute for Education
Feldbrunnenstrasse 70
2 Hamburg 13, GERMANY

Professor Saul B. Sells
Institute of Behavioral Research
Texas Christian University
Fort Worth, Texas 76129

Dr. Madhuri R. Shah
11, Manav Mandir Road
51, "Anupam"
Bombay-6, INDIA

Dr. Carroll L. Shartle
Personnel Research Board
The Ohio State University
1775 South College Road
Columbus, Ohio 43210

The Ontario Institute for Studies in
Education
Library: Gifts and Exchange Section
252 Bloor Street West
Toronto 5, Ontario, Canada

Dr. H. S. Sichel
Operational Research Bureau
P. O. Box 10238
Johannesburg, SOUTH AFRICA

Professor W. Sjöstrand
Institutionen för Pedagogik
Sit Olovsg. 12
Uppsala Universitet
Uppsala, SWEDEN

Dr. Denzel D. Smith
Division of Institutional Programs
Room 420
National Science Foundation
1800 G Street, N. W.
Washington, D. C. 20550

Dr. G. Sokoloff, Secretary
International Association for Educational
and Vocational Information
29, rue D'Ulm
Paris, FRANCE

Professor Julian C. Stanley
Department of Education
Johns Hopkins University
Baltimore, Maryland 21218

Department of Educational Psychology
Library
7 Foster Annex
State University of New York
at Buffalo
Buffalo, New York 14214

Dr. Lawrence M. Stolurow
Computer-Aided Instruction Laboratory
Harvard University
46 Concord Avenue
Cambridge, Massachusetts 02138

Professor Patrick Suppes
Ventura Hall
Stanford University
Stanford, California 94305

Dr. Nils-Eric Svensson
Research Planning Bureau
National Board of Education
Stockholm 22, SWEDEN

Dr. Erik Thomsen
The Danish Institute for Educational
Research
101 Emdrupvej
Copenhagen NV, DENMARK

Department of Educational Psychology
University of Tokyo
Hongo, Bunkyo-ku
Tokyo, JAPAN

Mr. Maurice E. Troyer
School of Education
Syracuse University
Syracuse, New York 13210

Dr. Donald W. MacKinnon
Department of Psychology
University of California
Berkeley, California 94720

Chief, Research Division
Office of Director of Admissions
and Registrar
USMA
West Point, New York 10996

Dr. D. A. Walker
Scottish Council for Research
in Education
46 Moray Place
Edinburgh 3, SCOTLAND

Dr. S. W. Wiseman
National Foundation for Educational
Research
The Mere, Upton Park
Slough, Bucks, ENGLAND

Dr. Sam C. Webb
Director of Evaluation Studies
Georgia Institute of Technology
Atlanta, Georgia 30332

Dr. David J. Weiss
Research Director
Work Adjustment Project
University of Minnesota
Minneapolis, Minnesota 55455

Dr. Alexander G. Wesman
Associate Director, Test Division
Psychological Corporation
304 East 45th Street
New York, New York 10017

The Librarian (Periodicals Dept.)
University of Western Australia
Nedlands, Western Australia
AUSTRALIA

Dr. Warren W. Willingham
College Entrance Examination Board
475 Riverside Drive
New York, New York 10027

Mr. Logan Wilson, President
American Council on Education
1785 Massachusetts Avenue, N. W.
Washington, D. C. 20036

Laboratory of Experimental Design
The University of Wisconsin
1404 Regent Street
Madison, Wisconsin 53706

Dr. J. Wayne Wrightstone, Director
Bureau of Educational Research
New York City Board of Education
110 Livingston Street
Brooklyn, New York 11217

The Librarian
Department of Education and Science
P. O. Box 826
Canberra City, A.C.T. 2601
Australia

Serials Department
General Library
University of California
Berkeley, California 94720

Supplement to Research Report Distribution List

Requests for Specific Subjects

Mr. J. B. Boyd Personnel Research Supervisor The Hydro-Electric Power Commission of Ontario 620 University Avenue Toronto 2, CANADA	Engineering
Dr. Edwin A. Fleishman Vice President and Director American Institutes for Research 8555 16th Street Silver Spring, Maryland 20910	Reports by H. Gulliksen
Professor James T. Fleming Reading Department School of Education State University of New York 1400 Washington Avenue Albany, New York 12203	Child Language Development and Reading
Gift Section Exchange and Gift Division Library of Congress Washington, D. C. 20540	College Board Reports
Mr. Bjorn Hoijer Psykologiska Institutionen Uppsala Universitet Uppsala, SWEDEN	Computer
Professor D. V. Lindley Department of Statistics University College London W.1, ENGLAND	Psychometric Group
Mr. Leslie T. MacMitchell College Entrance Examination Board 475 Riverside Drive New York, New York 10027	College Board Reports
Dr. Salvatore R. Maddi Department of Psychology University of Chicago Chicago, Illinois 60637	Personality
Mr. Hollace Roberts 625 Colfax Evanston, Illinois 60201	College Board Reports